Let There Be Light

Screen brightness is an objective measure of how much light is reflected from the screen to the audience. SMPTE Standard 1 96M specifies that it be measured with the projector in normal operation, but with no film in the aperture. Measurements are made using a spot photometer having the same spectral sensitivity as the human eye. Good meters meeting these requirements cost a few thousand dollars.

Measurements should be made from several locations, since not everyone sits in the center seat. Although the standard specifies a screen luminance of 1G +/ 2 footlamberts (55 +/ 7 cd/m2) for review rooms (where the desired color and density of prints are decided by the director, cinematographer and film laboratory), it allows a range of 12 to 22 footlamberts (41 to 75 cd/m2) for theatres. Most people only remember the nominal aim of 16 fL.

The image should be uniformly bright across the screen, without any "hot spots" or dark areas. The screen sides should be 75 to 90 percent of the screen center luminance, but not less than 10 fL (34 cd/m2).

Is Screen Luminance Level Important?

To understand why screen luminance is important, we need to understand human vision. During the daylight, our vision is fully functional so colors appear brighter, and we see with maximum sharpness. In dim light, colors appear desaturated, and we may have problems seeing detail. At intermediate levels of light, we may see color and detail, but not with the same vividness. Theatre screens fall into this intermediate level, where a small increase in luminance can make a big improvement in color perception and visual acuity.

Is Brighter Better?

To demonstrate the effect of screen luminance on image quality, we made two identical prints, color timed at the laboratory screening room standard of 16 fL. We included a variety of scenes having highlights, shadows, fleshtones, bright and pastel colors, and good sharpness. The matched prints were projected side-by-side on identical projectors, one at 12 footlamberts, and the other at 22 footlamberts.

The print projected at 22 fL had greater tonal range, sparkling highlights, more detail in the shadows, livelier and more natural flesh tones, brighter colors, and appeared sharper. There was slightly more shutter flicker in the very bright scenes, and underexposed scenes had lighter blacks. But almost all audience members preferred the brighter projector. In their minds, "brighter IS better."

At higher screen luminance, most scenes will look better, but the colors may be brighter or the shadow detail more visible than when the director and cinematographer viewed it. But at lower screen luminance, the audience will always be shortchanged. Dim pictures look dull and lifeless, and never match what the director wanted.

Today's Situation

Recent surveys have shown that the vast majority of theatres are too low in screen luminance. Data reported by the Lucasfilm Theatre Alignment Program (TAP) showed the average screen luminance in first-run theatres to be about 11 flL. A Kodak survey of theatres in one major city found first-run theatres with screen luminance as low as 7 fL in the center, and less than 5 at the edges. The Kodak survey also found multiple causes for the below-standard luminance, including inadequate lamp power, improper lamp alignment, dirty or improperly installed screens, etc. In most cases, theatres were unaware of how dim their pictures actually were, since they didn't have a spot meter, and had the luminance measured infrequently.

Sometimes, the problem was misinformation. For example, many theatre managers believe you save money by running a xenon bulb below its rated current. In reality, although this may save a little electricity, it may actually shorten the life of the very expensive bulb. If the quartz envelope of the bulb runs too cool, deposits will form, blackening the bulb.

Some managers say, "My multiplex doesn't need a light meter to check screen luminance and light distribution—that's done once a year by our service engineer, and adjustments are made then to bring us back into specification." The reality is that screen luminance changes as bulbs age and screens get dirty and any time you change or rotate a bulb. The only way to be sure your screen luminance is correct is to measure it with a meter periodically, and whenever anything is changed. Although a proper screen luminance meter is expensive, it is a wise investment that can be prorated over multiple screens

and many years of use.

The Future

Kodak is working on ways to help theatres improve screen luminance. Kodak print film is very resistant to heat damage and dye migration caused by excessive radiant energy, so that with proper alignment and heat filtration, even a 7000-watt bulb can be used. We continue to encourage the use of 70mm prints to fill the huge screens that can entertain over 500 people at a showing.

Someday, it may be possible to consider a higher aim for screen luminance, and the quality improvement that it would bring. For now, we need to do all we can to have all theatres meet the existing SMPTE standard, so that dim pictures are a faded memory.

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